



NASA's Orbiter Fleet

Discovery



Endeavour



Atlantis

Original Fleet

At Kennedy Space Center, the Space Shuttle Program is making the Vision for Space Exploration a reality. Every launch is a step into the future.

Originally, NASA's fleet of working orbiters comprised five ships: Challenger, OV-099; Columbia, OV-102; Discovery, OV-103; Atlantis, OV-104; and Endeavour, OV-105. Challenger was lost during launch in January 1986. Columbia, the flagship of the fleet, was lost during approach to landing in February 2003.

The first of NASA's orbiter fleet, Columbia was delivered to Kennedy Space Center in March 1979. Columbia initiated the Space Shuttle flight program April 12, 1981, when it lifted off Pad A in the Launch Complex 39 Area at KSC. It proved the operational concept of a winged, reusable spaceship by completing the Orbital Flight Test Program, missions STS-1 to STS-4. STS refers to Space Transportation System.

Columbia was named after a Boston-based sloop that operated out of Boston in 1792 and explored the mouth of the Columbia River on the West Coast of North America. The same ship was the first American vessel to circumnavigate the globe. Also sharing the name is the first U.S. Navy ship to circle the globe and the command module for the Apollo 11 lunar mission.

Discovery

Discovery, the third in NASA's fleet of reusable, winged spaceships, arrived at Kennedy Space Center in November 1983. It was launched on its first mission, flight 41-D, on Aug. 30, 1984, and carried three communications satellites aloft for deployment by its astronaut crew.

Other Discovery milestones include the deployment of the Hubble Space Telescope on mission STS-31 in April 1990, as well as the second Hubble servicing mission STS-82 in February 1997; the launching of the Ulysses spacecraft to explore the Sun's polar regions on mission STS-41 in October 1990; the deployment of the Upper Atmosphere Research Satellite in September 1991; and the second flight to the International Space Station on mission STS-96 in May 1999.

Discovery is named for two famous sailing ships: one sailed by Henry Hudson in 1610 and 1611 to explore Hudson Bay in Canada, as well as search for a northwest passage between the Atlantic and Pacific Oceans, and the other by James Cook in the 1770s on voyages in the South Pacific, during which he discovered the Hawaiian Islands.

The British Royal Geographical Society used two ships named Discovery: one to explore the North Pole in 1875 and one to explore the Antarctic in 1904.

The orbiter Discovery touches down Aug. 22, 2001, at KSC's Shuttle Landing Facility to conclude the 12-day STS-105 mission to the International Space Station. The mission was Discovery's 30th flight.



Atlantis

The fourth orbiter, Atlantis, was delivered to Kennedy Space Center in April 1985. It lifted off on its maiden voyage on Oct. 3, 1985, on mission 51-J, the second dedicated Department of Defense flight. Later missions included the launch of the Galileo interplanetary probe to Jupiter on STS-34 in October 1989, and launch of the Gamma Ray Observatory on STS-37 in April 1991. Others were STS-71 and STS-74, the first and second MIR dockings; six SPACEHAB missions from March 1996 through September 1997; and six flights to the International Space Station from May 2000 to October 2002.

Atlantis is named after a two-masted, 460-ton ketch that was operated for the Woods Hole Oceanographic Institute from 1930 to 1966. The ketch was the first U.S. vessel to be used for oceanographic research.



In the Vehicle Assembly Building, the orbiter Atlantis is lowered into position for mating to its External Tank/Solid Rocket Booster stack for launch on mission STS-104 July 12, 2001.



Endeavour lands Dec. 7, 2002, at KSC's Shuttle Landing Facility after the 14-day mission STS-113 to the International Space Station.

Endeavour

Authorization to construct the fifth Space Shuttle was granted by Congress on Aug. 1, 1987. Endeavour first arrived at KSC's Shuttle Landing Facility May 7, 1991, atop NASA's new Shuttle Carrier Aircraft (NASA 911). The space agency's newest orbiter began flight operations in 1992. Significant missions included the first SPACEHAB mission, STS-57, in June 1993; the first manned flight to the International Space Station, STS-88, in December 1998, carrying the Unity connecting module; and the Shuttle Radar Topography Mission, STS-99, in February 2000.

Endeavour is named after the first ship commanded by 18th century British explorer James Cook. On its maiden voyage in 1788, Cook sailed into the South Pacific and around Tahiti to observe the passage of Venus between the Earth and the Sun. During another leg of the journey, Cook discovered New Zealand, surveyed Australia and navigated the Great Barrier Reef. A national competition in public schools produced the name of this fifth orbiter.

Orbiter Upgrades

When built, Endeavour featured new hardware designed to improve and expand orbiter capabilities. Most of this equipment was later incorporated into the other three orbiters during out-of-service major inspection and modification programs. The upgrades include:



Columbia sits on Launch Pad 39A before its maiden flight on STS-1, April 12, 1981.

- a 40-foot-diameter drag chute that reduces the orbiter's rollout distance by 1,000 to 2,000 feet.
- plumbing and electrical connections needed for Extended Duration Orbiter (EDO) modifications to allow up to 28-day missions.
- updated avionics systems that include advanced general purpose computers, improved inertial measurement units and tactical air navigation systems, enhanced master events controllers and multiplexer-demultiplexers, a solid-state star tracker and improved nose wheel steering mechanisms.
- an improved version of the Auxiliary Power Units that provide power to operate the Shuttle's hydraulic systems.

Columbia was the first online orbiter to undergo the first scheduled inspection and retrofit program. The ship was transported Aug. 10, 1991, after its completion of mission STS-40, to Shuttle contractor Rockwell International's Palmdale, Calif., assembly plant, where the work was performed.

Columbia underwent approximately 50 modifications, including the addition of carbon

brakes and a drag chute, improved nose wheel steering, removal of development flight instrumentation and an enhancement of its Thermal Protection System.

The orbiter returned to KSC Feb. 9, 1992, to begin processing for mission STS-50 in June of that year. Columbia was sent to Palmdale in 1999 for a second round of upgrades, returning to KSC in 2001.

The orbiters' EDO changes allowed them to support missions up to 16 days long.

The upgrades that made a longer stay in space possible included the EDO pallet, which holds a set of liquid hydrogen and liquid oxygen tanks to provide additional fuel for the orbiter's electrical power generation system. In addition are a regenerating system for removing carbon dioxide from the crew cabin atmosphere; two additional nitrogen tanks for cabin air; an improved waste collection system; and additional middeck lockers for storage.

In 2002, Orbiter Major Modifications (OMM) were moved from Palmdale to Kennedy Space Center. Discovery was the first orbiter to go through OMM at KSC.

Modifications

Many modifications have been made to the orbiter fleet since the vehicles were first built, including improvements to the main engines, thermal protection system and propellant supply systems, and installation of a new crew escape system.

Main engine modifications included changes to the high-pressure turbo machinery, hydraulic actuators and main combustion chamber.

Some of the tiles that make up the orbiter thermal protection system were replaced to make the system lighter, stronger and more durable. Also, a Reinforced Carbon-Carbon panel was added to the orbiter chin between the nose cap and the nose wheel-well door to provide improved insulation against the searing heat experienced during reentry into the Earth's atmosphere.

Improvements to the orbiter propellant supply system included a redesigned, 17-inch quick-disconnect valve between the orbiter and the External Tank. Additional modifications were made to the propellant systems of the orbiter reaction control system, orbital maneuvering system and the auxiliary power units.

A new crew escape system was added that allows the Space Shuttle crew to bail out if the orbiter has to make an emergency return descent and a safe runway cannot be reached. This system consists of an escape pole that can be extended from the opened crew hatch. The crew would then fasten a lanyard hook assembly that is a part of the pole to their parachute harnesses. Once attached to this hook, the crew would slide down the deployed pole, away from the orbiter. Once free of the pole, they would parachute to safety.

Two more recent upgrades on the orbiters are installation of the "glass cockpit" and improved Space Shuttle main engines.

Both Discovery and Atlantis have received the new full-color, flat, 11-panel Multifunction Electronic Display Subsystem. The new system improves crew/orbiter interaction with easy-to-read, graphic portrayals of key flight indicators like attitude, altitude and speed.



The "glass cockpit" provides easy-to-read, graphic portrayals of key flight indicators like attitude, altitude and speed.

Another improvement to the Space Shuttle's propulsion system is the Block II Main Engine configuration that includes a new Pratt & Whitney high-pressure fuel turbopump. The new turbopump made its debut flight on Atlantis in July 2001 on mission STS-104. The Block II configuration results in a more reliable and safer engine due to increased pump robustness.

The primary modifications to the engine are the elimination of welds by implementing a casting process for the housing, an integral shaft/disk with thin wall blades and ceramic bearings. The unique casting makes the pump stronger and will increase the number of flights between major overhauls.

Other significant improvements in the Shuttle's main engines are the high-pressure liquid oxygen turbopump, the two-duct power-head, the large throat main combustion chamber and the single-coil heat exchanger.

In response to the Columbia accident and recommendations of the Columbia Accident Investigation Board, there were 41 modifications for Return to Flight in 2005. Eight of these were significant.

Future modifications include an Advanced Thrust Vector Control System that will provide an updated steering source for the Solid Rocket Boosters.

Final Preparations for Another Flight

After completing a space mission, the orbiter is returned to KSC where it will undergo preparations for its next flight in a sophisticated aircraft-like hangar called the Orbiter Processing Facility (OPF). Here, the vehicle is safed, residual propellants and other fluids are drained, and returning horizontal and middeck payloads are removed.

Any problems that may have occurred with orbiter systems and equipment on the previous mission are checked out and corrected. Equipment is repaired or replaced and extensively tested. Any modifications to the orbiter that are required for the next mission are also made in the OPF.

Orbiter refurbishment operations and processing for the next mission also begin in the

OPF. Large horizontal payloads, such as the Multi-Purpose Logistic Modules, are installed in the orbiter cargo bay. Vertical payloads, such as components for the Space Station, are installed at the launch pad.

Following extensive testing and verification of all electrical and mechanical interfaces, the orbiter is transferred to the nearby Vehicle Assembly Building where it is mated to the External Tank and attached Solid Rocket Boosters atop the Mobile Launcher Platform (MLP).

Then, the assembled Space Shuttle vehicle on the MLP is carried to the launch pad by a large tracked vehicle called the Crawler Transporter.

At the launch pad, final preflight and interface checks of the orbiter, its payloads and associated ground support equipment are conducted. After a positive Flight Readiness Review, the decision to launch is made and the final countdown begins.



Space Shuttle Endeavour, with its stack of Solid Rocket Boosters and External Tank, sits on Launch Pad 39A for launch of STS-113 in November 2002. At lower left is the White Room, situated at the end of the Orbiter Access Arm, which provides entry into the orbiter for the crew.

Specifications

Space Shuttle

- Height: 184.2 feet
- Gross Liftoff Weight: 4,500,000 pounds
- Total Liftoff Thrust: 7,145,000 pounds

Orbiter

- Length: 122.17 feet
- Wingspan: 78.06 feet
- Landing Weight: 242,000 pounds
- Main Engines(3): 375,000 pounds of thrust each at sea level
- Cargo Bay: Length – 60 feet
Diameter – 15 feet

Solid Rocket Boosters (2)

- Length: 149.16 feet.
- Diameter: 12.17 feet.
- Liftoff Weight (each): 1,300,000 pounds
- Recovery Weight (each): 192,000 pounds thrust; 3,060,000 pounds at sea level

External Tank

- Length: 153.8 feet
- Diameter: 27.6 feet
- Weight: 58,500 pounds
- Fueled at Liftoff: 1,648,000 pounds

Propellants

- Liquid Oxygen: 141,750 gallons (1,350,000 pounds)
- Liquid Hydrogen: 384,071 gallons (227,800 pounds)

Atlantis launches Oct. 7, 2002,
on mission STS-112.



NASA: Explore. Discover. Understand.